

## METHOD FOR UPGRADING A DIAL INDICATOR TO PROVIDE REMOTE INDICATION CAPABILITY

### 5 Related Applications

This application claims the benefit of U.S. Provisional Patent Application Ser. No. 60/282,054, entitled Capacity Measurement Device For A Liquid Storage Tank, filed 04/07/01.

### 10 BACKGROUND OF THE INVENTION

#### (1) Field of the Invention

The present invention relates generally to a dial indicator, and more particularly relates to a dial indicator capable of providing both local visible indication and remote indication of a physical parameter.

#### 15 (2) Background Information

Dial indicators (also variously referred to as dial gauges, indicator gauges, dial faces, and/or analog gauges) are commonly used to indicate a host of physical parameters such as temperature, pressure, electrical properties, liquid levels, among others. For example, liquid storage tanks for fuel, oil, propane, natural gas, and ammonia typically include a dial indicator attached thereto for providing an on-site, visible reading of the liquid level (i.e., the percentage of the total tank volume occupied by the liquid. For many applications it is desirable, both for convenience and economic factors, to have both local visible indication and remote indication of the above-mentioned physical parameters. For example, it is generally necessary for a user to be aware of the quantity of remaining liquid in a liquid storage tank, such as for determining when refilling is necessary. In some industrial applications, in which large numbers of tanks are employed, remote indication may be desirable. However, local visual indication may also be desirable, for example, to monitor the filling operation.

Examples of indicators providing both on-site and remote indication are disclosed in U.S. Patents 4,554,494 to Howeth; 4,911,011 to Fekete, et al.; 4,975,687 to Murphy, Jr. et al.; 4,987,400 to Fekete; 5,305,639 to Pontefract; and 5,357,815 to Williamson; each of which is fully incorporated by reference herein. Fekete, et al., in U.S. Patents 4,911,011 and 4,987,400, for example, disclose a dial indicator having a

magnetically driven voltage divider built into the device behind the dial face for providing an electrical indication of liquid level in a liquid storage tank.

The above systems tend to be complex and therefore may be relatively expensive. Further, for some applications for which both local and remote indication are desirable, it may not be economically feasible to replace the existing gauge. Further still, for many applications, dial indicators providing for both local visual and remote indication may not be commercially available. Therefore, there exists a need for a relatively simple and inexpensive dial indicator that provides for both onsite and remote indication. There also exists a need for a relatively simple and inexpensive method for upgrading a conventional dial indicator (which provides only visual indication) to include the capability of providing remote indication.

#### SUMMARY OF THE INVENTION

One aspect of the present invention includes a method for upgrading a dial indicator to provide both local visible and remote indication of a physical parameter. The method includes providing the dial indicator with a magnetic rotary pointer, the magnet rotary pointer being rotatable in response a change in the physical parameter. The method further includes magnetically coupling a potentiometer to the magnet, the potentiometer being magnetically adjustable, wherein a rotation of the magnet causes a change in the electrical output of the potentiometer and fastening said potentiometer to a front side of the dial indicator. In variations of this aspect, the magnetic rotary pointer is provided by securing a magnet to a pre-existing rotary pointer, or by replacing the pre-existing rotary pointer with a replacement rotary pointer having a magnet integrated therewith. In another variation of this aspect the dial indicator is mounted to a liquid storage tank and the potentiometer is fastened to the dial indicator by interposing it between a transparent bracket and a transparent cover, and fastening the bracket to the dial indicator.

In another aspect, this invention includes a kit for upgrading a dial indicator to provide both local visible and remote indication of a physical parameter. The kit includes a magnet, sized and shaped for coupling to the dial indicator in a manner in which the magnet rotates in response to a change in the measured physical parameter, a magnetically adjustable potentiometer, and a mounting assembly that includes a bracket, sized and shaped for fastening the potentiometer to the dial indicator. In variations of this aspect, the magnet may be sized and shaped for being secured to a pre-existing

rotary pointer of the dial indicator, or the magnet may include a replacement rotary pointer.

In yet another aspect, this invention includes a dial indicator for providing a local visible and a remote display of a liquid level in a liquid storage tank. The dial indicator includes a magnetic rotary pointer which is rotatable in response to a change in the liquid level in the tank. The dial indicator further includes a magnetically adjustable potentiometer including a voltage divider and at least two electrical connectors, the potentiometer being magnetically coupled to the magnetic rotary pointer so that rotation of the magnetic rotary pointer causes a change in the electrical output of the potentiometer. The potentiometer is mounted to a front side of the dial indicator by a transparent bracket. In variations of this embodiment, the magnetic rotary pointer includes a rotary pointer having a magnet secured thereto, or includes a replacement rotary pointer having a magnet disposed integrally therewith.

#### BRIEF DESCRIPTION OF THE DRAWINGS

**Figure 1** is a perspective schematic representation of a fuel tank assembly including the present invention;

**Figure 2** is a schematic, front view representation of a prior art dial indicator of the type useful in conjunction with the present invention;

**Figure 3** is a schematic, front view representation one embodiment of a dial indicator configuring according to the present invention;

**Figure 4** is an exploded perspective schematic view of the dial indicator of Figure 3;

**Figure 5** is a view similar to that of Figure 4, of another embodiment of this invention;

**Figure 6** is a flow chart representation of one embodiment of the method of this invention; and

**Figure 7** is a view similar to those of Figures 4 and 5, of another embodiment of this invention.

#### DETAILED DESCRIPTION

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Referring now to Figure 2, a conventional dial indicator 20 typically includes a housing 21 having a faceplate 24 with indicia 25 printed thereon. A rotary dial pointer 22 coupled to a conventional sensor mechanism (not shown) provides for a visible

indication of the measured physical parameter. Dial indicator 20 also typically includes a transparent cover 27 (see Figures 4-5) on the front face thereof.

Referring again to Figures 3-5, embodiments of a dial indicator 40 including the present invention are illustrated and described in more detail. Referring initially to Figure 3, dial indicator 40 is similar to dial indicator 20 in that it includes a housing 21 having a faceplate 24 with indicia 25 printed thereon and a rotary pointer 22 for providing a visible indication of the measured physical parameter. Rotary pointer 22 may be any type that is typically used in gauges known in the art, such as shown and described in U.S. Patent 4,975,687 to Murphy, Jr. et al. Dial indicator 40 further includes a potentiometer 46 (described in greater detail hereinbelow), typically having at least two electrical connectors 47 coupled thereto for providing an electrical output indication of the measured physical parameter. Potentiometer 46 is typically fastened to the front side of dial indicator 40 by a bracket 42, which may be fastened to housing 21 using conventional fasteners 43 (e.g., screws, bolts or pins threaded or otherwise inserted into one or more recesses 44 (Figures 4-5) in housing 21). The term "front side", as used herein, shall refer to the side of the dial indicator from which a visual reading may be obtained. Bracket 42 is typically, but not necessarily, constructed of an optically transparent material, such as a relatively clear plastic sold under the trademark PLEXIGLAS® (Rohm & Haas Company, Philadelphia Pennsylvania), or under the trademark LEXAN® (General Electric Company, Pittsfield Massachusetts). The bracket may also be fabricated from various opaque materials, such as aluminum or stainless steel. The bracket 42 is fastened to the front side of potentiometer 46 and screwed into housing 21.

Referring now to Figures 4 and 5, dial indicators 40 and 40' of this invention further include one or more magnets 30, 30' physically coupled to rotary pointer 22. Magnet(s) 30, 30' may be any type having north 30N, 30N' and south 30S, 30S' poles and are typically relatively small in order to be easily installed in the dial indicator 40, 40'. In embodiment 40 (Figure 4), a horseshoe magnet 30 is looped around the backside (i.e., opposite to front side) of the rotary pointer 22 and is disposed with its poles 30N, 30S oriented towards the front side of the dial indicator 40. In another embodiment indicator 40' (Figure 5) includes a magnet 30', in which opposite sides or ends have opposite poles 30N', 30S', and which is physically coupled to the rotary pointer e.g., by gluing it to the front side thereof.

Magnet 30' may be a bar magnet, or may be a thin horseshoe magnet (similar in size and shape to a coin, having both poles 30N' and 30S' on the same flat side thereof). Such a magnet may be provided with a central hole (not shown) through which a rivet or similar fastener may extend to attach the magnet to the pointer at its axis of rotation.

5 Still further, a pair of magnets 30'', each having poles 30N' and 30S' on opposite sides thereof, may be provided as shown in Figure 7. These magnets 30'' may be fastened to the pointer (e.g., using glue), with opposite poles facing the potentiometer 46. Use of multiple magnets 30'' may be particularly useful in retrofit applications, as discussed in greater detail hereinbelow. As shown, multiple magnets 30'' may be balanced about the

10 axis of rotation of pointer 22 (e.g., magnets 30'' may be disposed on opposite sides of the axis of rotation of the pointer) to help prevent uneven or excessive wear of the pointer mechanism. Alternatively, in the event it is desirable to dispose one or more magnets 30, 30', 30'' assymmetrically about the axis of rotation, one or more weights may be applied to the pointer 22 where desired to counterbalance the magnet(s). Magnet(s)

15 30, 30', 30'' are thus coupled to rotary pointer 22 in a manner that allows them to rotate with the pointer 22 in response to a change in the measured physical parameter. As a still further alternative, a replacement pointer 22 may be provided, having magnet(s) 30' 30'' integrally disposed therewith, such as for inclusion in a kit as discussed hereinbelow. For example, replacement pointer 22 may include a magnet fabricated in

20 the form of a rotary pointer.

Potentiometer 46 may be any that may be adjusted by the rotation of a magnetic field (hereafter referred to as magnetically adjustable) and is magnetically coupled to magnet 30, 30', 30''. A change in the orientation of rotary pointer 22 therefore changes the electrical output of potentiometer 46. As mentioned hereinabove potentiometer 46

25 typically includes at least two electrical connectors or ports (e.g., wires), which may be connected to a remote display (e.g., remote display 110). Alternatively, as described above, the electrical output may be used in combination with a radio frequency or other wireless communication device to provide for remote monitoring. Further, potentiometer 46 typically includes a diameter less than about half that of dial indicator

30 40 in order not to obscure visual reading of the indicator 40. In one embodiment, potentiometer 46 may be a single-turn, magnetically adjustable voltage divider. In another embodiment, potentiometer 46 may include another dial indicator having an

internal magnetically actuatable voltage divider (e.g., the Twinsite® potentiometer (P/N P5928S02669) as manufactured and sold by Rochester Gauges, Inc., Dallas, TX).

This invention may also include a kit for upgrading a prior art dial indicator 20 to provide both local visible and remote indication of a physical parameter. The kit may include one or more magnets 30, 30', 30'' sized and shaped for coupling to a rotary pointer 22 so that the magnet rotates with the rotary pointer 22 in response to a change in the measured physical parameter. (The kit may alternatively include a replacement (i.e., substitute) pointer 22 having one or more magnets integrally disposed thereon, as mentioned hereinabove.) The kit may also include a magnetically adjustable potentiometer 46 and a mounting assembly that includes a bracket 42, sized and shaped for fastening the potentiometer 46 to the dial indicator 20, and at least one fastener 43. The kit may further include a remote display 110 for providing remote indication of the measured physical parameter. The kit may still further include components necessary for linking the potentiometer 46 to the remote display, such as electrical wire, telephone wire, a modem, a radio transmitter/receiver, and the like. As mentioned hereinabove, use of multiple magnets 30'' may be advantageous in retrofit applications, since the magnets 30'' may be fastened to the pointer 22 without requiring removal or disassembly of the pointer 22, to provide relatively simple and quick installation.

Referring now to Figure 6, an embodiment of the method of this invention is described in more detail. At 52 a conventional dial indicator 20 is used or provided. Dial indicator 20 may be configured to monitor any of numerous physical parameters such as temperature, pressure, liquid level, and the like. In one useful embodiment, a dial 20 indicator mounted to a liquid storage tank (e.g., a liquefied natural gas, a liquid propane, or a liquid ammonia storage tank) is utilized. At 53, the dial indicator cover 27 may optionally be removed. It may be further necessary to remove the rotary pointer 22 and its associated bearing assembly. At block 54 one or more magnets 30, 30', 30'' (Figures 4, 5, and 7) are physically coupled to the rotary pointer 22 in a manner that allows them to rotate with the pointer 22, as discussed hereinabove. At 55 the cover 27 may be refastened to the dial indicator 20. For some applications it may be necessary to modify (e.g., bend or cut) the cover 27 in order to prevent it from interfering with the installed magnet(s) 30, 30'. At 56, a potentiometer 46 is disposed on the front side of dial indicator 20 (e.g., on the front side of the cover 27) in a manner enabling it to be magnetically coupled to the magnet(s) 30, 30'. The potentiometer 46 is then fastened

to the dial indicator 20 using any known fastening means. For example, in one embodiment, a transparent bracket is disposed on the front side of the potentiometer 46 and screwed into the dial indicator housing 21 in order to hold the potentiometer 46 securely in place.

- 5           The modifications to the various aspects of the present invention described hereinabove are merely exemplary. It is understood that other modifications to the illustrative embodiments will readily occur to persons with ordinary skill in the art. All such modifications and variations are deemed to be within the scope and spirit of the present invention as defined by the accompanying claims.

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